THE SOCIO-ECONOMIC IMPACT OF THE FRESHWATER CRISIS IN MONGLA, BANGLADESH

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Abstract. Bangladesh is the lower country of three important international rivers[1], which, along with rainfall and groundwater, are the main sources of freshwater of the people on the coast. However, the effects of climate change, such as salinity, arsenic, drought, and cyclone, have generated a severe water crisis. Moreover, the ineffective management and governance, rather than solving, aggravated it. Based on my fieldwork experience in 2016-17, I aim to investigate the role of each of these sources, as well as the socio-economic problems arising from the failure of the government and other stakeholders involved in water management, in Mongla, Bangladesh, to solve it. The water crisis produces social threats like unemployment, an increase of working hours for women, the lack of marriage, migration, reduced income, high medical costs and drop out of school.

Keywords: climate change, freshwater crisis, unemployment, water management

INTRODUCTION

Water is a vital element for human development (Mustari and Karim 2016, 695). According to the United Nations, one-third of the world population lives in areas affected by the water crisis, of which 1.1 billion have no access to safe drinking water (Shaw and Thaitakoo 2010). The global water consumption is doubling every 20 years. Given this rate, at least 3 billion people will live in areas where fulfilling basic water needs will be very difficult or even impossible (*Concern Worldwide* 2012). Some authors assume a natural link

between water shortage and acute conflicts (Wolf 2001, 29), which the lead to severe political tensions, and even to war (Westing 1986, 9).

The water-related crisis is occurring especially in Asia, as the population growth and urbanization rate are high (Abedin et al. 2014, 111). Although Bangladesh is one of the most irrigated country in South Asia (150%) - followed by Sri Lanka (150%), India (133%) and Pakistan (110%) (Weligamage et al. 2002), it faces a severe water crisis generated by the effects of climate change. Its geographical position plays an important role, as it comprises the biggest part of the delta of Ganges-Brahmaputra-Meghna (GBM) (Zahid and Ahmed 2006, 27). The agriculture, biodiversity, livelihood, and culture of Bangladesh rely on water, and the supply of water largely depends on the multiple rivers system (74% of total water supplies) (Ahmed and Roy 2007, 39). However, the flow of these rivers is controlled by various diversion projects in the upstream country - India, a fact which affects the socio-economic development of Bangladesh.

The effects of climate change impacts, such as drought, erratic rainfall, salinity intrusion, higher temperature, cyclone, and storm, have both a direct and indirect effect on water resources and many people are struggling to access freshwater supplies especially in coastal Bangladesh (IPCC 2007, 472; Rabbani et al. 2013, 272-273). Although there are important resources of groundwater, salinity intrusion and arsenic contamination make them vulnerable (Mallick and Roldan-Rojas 2015, 93; WHO and UNICEF 2010). This crisis produces many socio-economic problems. For instance, millions of people use insecure drinking water, which causes diarrhoea, typhoid, parasites, cholera (Curry, 2010, 103), and malaria. A direct consequence is an increase in unemployment.

The following questions will be discussed below: (a) On which water sources should Bangladesh rely on? (b) Which role each of them plays in fulfilling the needs of the community? (c) What socio-

economic problems does the freshwater crisis create, and how could they be solved?

LITERATURE REVIEW

The demand and competition for water are increasing between countries due to the population and economic growth (UNDP 2006). There are 76 Upazila (sub-district) in 19 coastal districts of Bangladesh that are seriously affected by the rise of sea level (MoWR 2005). Freshwater is crucial for the coastal people not only for agriculture and industry but also for drinking and other household activities (Mustari and Karim 2016, 695). Many sources are available in the coastal region of Bangladesh, including groundwater, small ponds (with or without pond sand filters), rainwater and rivers (Mallick and Roldan-Roja 2015, 93). But they cannot supply a sufficient volume to meet the demand (Quazi, 2006, 3). This is because of inadequate freshwater aquifers at suitable depth (Islam et al. 2010, 3988; Kamruzzaman and Ahmed 2006, 377). Moreover, the deep tube wells do not work properly due to salinity and arsenic (Abedin et al. 2014, 111). There are no municipal reservoirs and the storage capacity for rainwater is not sufficient to fulfil the demand over the whole year (Ansari et al. 2011; Mallick and Roldan-Rojas, 2015). 30 million people are not able to collect freshwater. Half of them are forced to drink saline water (Hoque 2009, ix).

Surface water is also contaminated with salinity (Islam et al. 2013, 532) due to both natural and human causes. (Huq and Ayers 2008, 4; Mahmuduzzaman et al. 2014, 8-9; Rahaman and Bhattacharya 2006, 4-5). Among the first, the rise of sea level, cyclone, tidal surge, and floods are the most influential (Chong et al. 2014, 1585; Mustari and Karim 2014, 13; Shamsuddoha and Chowdhury 2007, 13-14). Unfortunately, by the year 2050, in the southwest areas of coastal Bangladesh, climate change might still increase the salinity of rivers

and groundwater (Dasgupta et al. 2014, i). The following table shows the rates of salinity level in the coastal districts of Bangladesh:

Table 01: Salinity level in the coastal districts of Bangladesh

District	Salinity in surface water in ppm
Bagerhat	5 - >10
Barguna	1- 5
Barisal	0
Bhola	1-10
Patuakhali	1-10
Pirojpur	0-10
Satkhira	5->10
Khulna	5->10

(Source: Islam 2004)

All of this makes the development of society stagnate (Huq and Ayers 2008, 7; Lal 2000, 57-58; Mustari and Karim 2016, 12-13): "Climate change deteriorates the situation significantly and reduced access to freshwater will lead to a cascading set of consequences, including impaired food production, the loss of livelihood security, large-scale migration within and across borders, and increased economic and geopolitical tensions and instabilities" (Abedin et al. 2014, 1).

The coastal community of Bangladesh is highly relying on fishing, rice, paddy farming, and aquaculture (Chowdhury 2010, 34; FAO 2009). The culture of shrimp has increased over the last 20 year, a fact which negatively affects the quality of ground and surface water (Datta et al. 2010). An "intentional flooding of lands by brackish water for shrimp cultivation makes the inhabitants of the area more vulnerable in terms of freshwater access" (Sultana et al. 2014,1), as shrimps need salt water to breed.

This scarcity causes tremendous socio-economic vulnerability and problems like an increase of the working hours of women,

health problems like cancers, cardiovascular diseases and skin lesions, and the decrease of the economic production (Joseph et al. 2015, 541; Rijberman 2006, 6; Vorosmarty et al. 2000, 284; Watkins 2006, 30; Mustari and Karim, 2016, 13-14). Women are carrying the duty of water collection in many developing countries (Mallick and Roldan-Rojas 2015, 92). It is internationally estimated that 64% of water collection is made by women (WHO and UNICEF 2011). Khan et al. (2011, 1) found that preeclampsia and gestational hypertension is prevalent among the women in the coastal areas than in the others. The lack of freshwater not only creates health problems but also is responsible for losing the opportunity for education, which affects the development of both individuals and the community (UNDP 2006).

RESEARCH MATERIALS AND METHODS

The present study was conducted in Chila village, Mongla Upazila[3] (22°29'N 89°36.5'E), in Bagerhat district of Bangladesh, during May and June 2017. The total population of this village is 7502 people, and the average household size is 4.1 (BBS 2015). The community is facing a freshwater crisis due to arsenic, salinity, and climate extreme events like cyclone, sea level rise, and drought. The crisis is acute in the dry season and generates many socio-economic problems.

This multidisciplinary study uses qualitative and quantitative research methods. The data were collected through Focus Group Discussions (FGD[4]), a survey of 80 households, and Key Informant Interview (KII[5]). Structured and semi-structured questionnaires and random sampling technique were used to gather data from these households. FGD was held before and after household survey in order to get knowledge and about the crisis, its related socio-economic problems, and their resilience. Five key informants were selected based on the age, socio-economic position, and literacy

level. The data were collected by the author with the assistance of trained university students in southern coastal Bangladesh during, June 2017. Collected data were analysed by using software like SPSS and NVivo.

FINDINGS AND ANALYSIS

The socio-economic background

Respondents' characteristics such as gender, marital status, age, number of children, occupation, and ownership of land help to identify how the freshwater crisis affects their development.

Socio-Economic Characteristics		Frequency	Percentage
Gender	Male	43	53.75
	Female	37	46.25
Marital Status	Married	69	86.25
	Unmarried	3	3.75
	Divorced	7	8.75
	Separated	1	1.25
Age (in years)	20 - 29	14	17.5
	30 - 39	31	38.75
	40 - 49	25	31.25
	50 -59	6	7.5
	60 - 69	2	2.5
	70 - 79	1	1.25
	80 - 89	1	1.25
Number of Children	0 – 2	44	57.14
	3 – 4	27	35.064
	5 – 6	4	5.19
	6+	2	2.59
Literacy Level	Illiterate	11	13.75
	Less than 5th degree	35	43.75

	5th to 10th degree	18		22.50		
	SSC – HSC	11		13.75		
	BA-MA	5		6.25		
Occupation	Primary	Freq.	%	Secondary	Freq.	%
	Fishermen	20	25.00	Day laborer	27	33.75
	Housewife	29	36.25	Fish farming	5	6.25
	Fisherwomen	3	3.75	Fisherwomen	11	13.75
	Day laborer	6	7.50	Rearing livestock	19	23.75
	Small business	4	5.00	Fishermen	7	8.75
	Trader	7	8.75	Rickshaw puller	3	3.75
	Farmer	3	3.75	Small business	8	10.00
	Driver	2	2.50			
	Fish farmer	5	6.25			
	Doctor	1	1.25			

Ownership of land (in bigha)/ Type of land	Bigha					
	0.1-3.0/Freq.	%	4-6/Freq.	%	7-9/Freq.	%
House	53	66.25	2	2.5		
Cropland	5		1	1.25	3	3.75
Landless	17	21.25	-	-	-	-

(Source: The author)

FRESHWATER SOURCES AND THEIR ROLE

Chilla community has the following freshwater sources: rainwater, rivers, groundwater, sweet ponds, and water traders. People are relying particularly on rainwater, which is however insufficient for the whole year, especially because they don't have the financial and technical capacity to stock it. Groundwater is contaminated with arsenic and salinity, so they cannot use it. Salinity also affects the rivers most of the year. Moreover, they have a direct connection with the Bay of Bengal, therefore it is unsafe to use it as a source. They can use rivers' water only during the monsoon because extreme rainfall reduces the salinity. Sweet ponds are a good source but they are not everywhere in Chilla. The distance from the study site to the first pond is five miles. Thus, people need to spend almost a whole day to collect water from it. There are water traders that collect water from this sweet pond and sale to the community. However, bottled water is the least viable option for this community because it is very expensive for them, considering their economic situation.

As Chilla is located in the coastal zone of Bangladesh, on the bank of Passur River, it is highly vulnerable to climatic phenomena like cyclone, tidal surge, and floods.

Table 03: Causes of the freshwater crisis in Chila (mutually inclusive)

Types	Frequency	Percentage
Drought	45	56.25
Flood (Tidal surge/storm surge)	57	71.25
Salinity	75	93.75
River Bank Erosion	19	23.75
Other (Specify) Storm	1	1.25

(Source: Islam 2017)

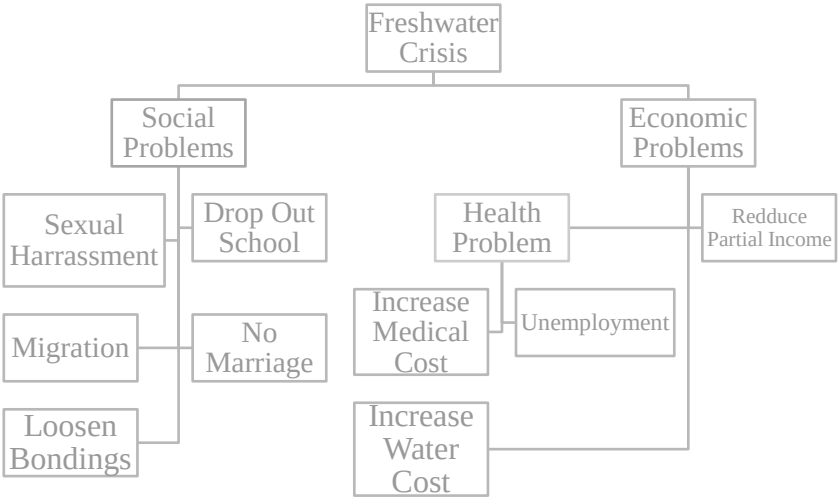
Socio-economic issues

The freshwater supply system is different in coastal areas. There are authorities responsible for supplying water to the people but they

are missing in Chilla. This happens even if it is well-known that water is crucial for poverty reduction, health improvement, biodiversity, and economic development. Instead, the lake of freshwater creates many problems like sexual harassment, drop out from school, migration, unemployment, a decrease in the number of marriages, as well as many specific health problems (*see* Figure 1).

As women are generally responsible for collecting water and supplying it to their households, the present crisis raises grave problems for them. The household survey revealed that all respondents from Chilla either buy or collect water. The water from the sweet pond is free but it requires spending considerable time to get it because of the long distance and interminable waiting times in queues. Sometimes, they are sexually harassed during these journeys. As per the questionnaire survey, 18.92% of female respondents are sexually harassed at least once every year, whilst 81.08% of them were once in their lives during the journey of water collection.

Figure 01: Social and Economic Problems due to the Freshwater Crisis



(Source: The author)

Although the freshwater crisis is not directly responsible for drop out of school, it creates a situation so girls choose this option. The frequency of water collection varies from season to season but it reaches the peak in the dry season[6]. Because rainfall rarely occurs, sweet ponds and rivers are dried. These are the main factors for such situations. Firstly, water collection requires a good period of time, which make girls fail to attend the school. Secondly, they are under enormous pressure during the dry season. They are exhausted after a long and laborious journey and lose interest to study. If they go to school without learning their lesson, the tutor humiliates them in front of the other students. In many cases, they choose not to go rather than suffering this treatment.

Regarding marriages, the parents from other neighbour villages are not interested to send their children to Chilla because of this crisis. They assume that their daughter would need to travel this long distance to collect water. Moreover, the boys are not interested in the girls in Chilla because of their rough skin caused by drinking and using saline water. According to the household survey, 41.25% of respondents informed that they are facing marriage problems.

It is a very difficult task for females to ensure sufficient and safe freshwater supplies for the household. Consequently, some of them decide to leave their ancestor's place and start a new life somewhere else. According to the household survey, if the freshwater crisis persists in the next five years, 18.75% of respondents will migrate from Chilla.

In the dry season, women need to spend more time to collect water[7] and, in turn, they have less time for other household tasks. This fact creates tensions and conflicts and leads to domestic violence. It also creates distance in the relationship between husband and wife, which then leads to separation or divorce.

Regarding the economic development of the community, the freshwater crisis means more expenditure on health, less employment, and reduces income. Freshwater is important for health and our study found that the people from this region face

health-related problems like diarrhoea, skin problems, malaria, and dysentery, mostly in the dry season. A key informant, Arcona Roy, told us that, in 2016, she could not work for one month because of diarrhoea. She also needed to spend around BDT[8] 1700 (20.49 USD) for treatment. This is a direct expenditure. However, if she converts the time lost in monetary value, then the total loss would be BDT 8000 (96.4 USD). According to the household survey, 97.50% of respondents said that they are facing at least one of the above-mentioned health problems at least once during the dry season. This affects their employment possibilities and increases medical costs.

In Chilla, employment options vary season to season. They largely depend on the availability of fish in the river. As per the questionnaire survey, 98.75% of participants admit that they are involved in the fishing sector so that they have more opportunities for employment during the monsoon than in the dry season. Villages of the bank of Passur River catch fishes from the river and sell them in the market or work as day labourers for the fishermen who have a trawler and other materials for catching them in large quantities. Yet, they lose this opportunity is they are not physically fit during this period, a fact which depends on the water supplies. The survey indicated that 78.75% of participants lost it at least once during their life.

The members of this community also rely on various sources of partial income to fulfil their needs. Fishermen and boatmen are, for instance, busy in the monsoon and have free time in the dry season. During this season, they are trying to migrate temporarily (e.g. to Dhaka or other urban areas). As the freshwater crisis is prominent, they are facing more health problems, which makes them unable to look for a temporary job. Moreover, they need to stay home and help their families to collect water.

Rearing livestock is another good source of partial income. It is a traditional practice in coastal Bangladesh. Some of them rely on livestock even as their main source of income. They earn good

amount of money from selling livestock and eggs. This activity also meet the nutritious demand of the family. But rearing livestock is not possible during the dry season because they cannot share their hard work in collecting water with animals. Consequently, their income dramatically decrease.

As the existing freshwater sources cannot supply sufficient volume to the community, the last relies on water traders. But they do not supply it without charge. The price depends on the location of the household. If it is located in a place that water traders can easily reach, the price varies between BDT 20-25 (0.24-0.3 USD) for one jar[9] of water. If it is far away, they charge BDT 30-40 (0.3-0.48 USD) for the same volume. This expenditure, which significantly increases during the dry season, puts an enormous pressure on this low-income community. Sometimes, traders stop supplying water without prior notice because they do not get enough from the sweet pond.

In order to solve these problems, the government has taken several initiatives, such as increasing the navigation on Gorai River by dredging, install water treatment systems, or increase awareness about rainwater harvesting. Despite these efforts, the situation has not improved.

Besides the household survey, we also conducted FGDs and KII to get an overall idea about the causes and consequences of the freshwater crisis and identify viable solutions. Some recommendations are summarized in the following:

Water can be used for multiple purposes without needing treatment People, for instance, can wash their hand and dishes in their vegetable gardens. This will reduce the water demand because they do not need to irrigate extra water. In this purpose, training and campaigns of sharing knowledge are needed. It is also important to find out who should benefit from training. The women and girls from rural areas are responsible to supply water to the families. They know how the freshwater crisis seriously affect the health and well-being of their relatives because if a family member suffers, additional

duties may fall on them. If they get training, it will be easy for them to bring efficiency in the domestic water use. Arcona Roi, a Key Informant, told us that she can use collected rainwater for four to five months for multiple purposes. For example, after eating, her family members wash their hand in a container. The water is then used to prepare food for chickens, ducks, and other animals. Before 2010, she could only use it for two to three months. In 2010, she got training from *World Vision* about collecting and the use of collected rainwater. Such training sessions should be provided for at least one member of each household, irrespective of their socio-economic position.

Installing rainwater harvesting systems (RHS) can be a good supplementary solution. The government should take the initiative to install such systems and create awareness among people about how to use them. This can be done by installing rainwater harvesting systems in all government offices, schools, colleges, and encourage the non-governmental organizations to install them in their offices. Moreover, it should take the initiative to provide poor communities like Chila with rainwater harvesting materials (e.g. large storage tanks, gutter pipes, switches, and others) without costs. For a long-term use of collected rainwater, people need knowledge and technical means for using and ensure the maintenance of RHS. For this purpose, the government should provide training to people, especially to women.

In order to make such projects sustainable, the government should undertake the following:

(1) Working together with national and international NGOs. For instance, it should use the network of local NGOs to provide training to people. The government can also use the same for creating mass awareness through rallies, campaigns, and field meetings.

(2) Make use of community knowledge and consider the local context in taking action. For instance, if the government initiates a project to supply shallow tube wells to people to withdraw water

from the ground sources, this project will not be viable because groundwater is contaminated with arsenic and salinity.
(3) Maintain good coordination with the local administration for managing the projects.
(4) Ensure transparency and accountability in the management of projects in order to the properly implement them at the grassroots level. Moreover, the government of Bangladesh should negotiate more frequently with India to ensure the equal share of transboundary river flow, following the existing treaty and international laws.

CONCLUSION

Water is everywhere in the coastal region. However, it is not safe for freshwater purposes, as it is contaminated with arsenic and salinity. Along with contamination, the effects of climate change, such as cyclone, drought, groundwater depletion, floods, as well as the lack of long-term sustainable solutions aggravate the water crisis. The available sources cannot supply a sufficient quantity of water to the households.

This present multidisciplinary study revealed that different kinds of socio-economic problems (such as sexual harassment, migration, drop out from school, income decrease, unemployment, increase in health expenditures, etc.) are caused by the freshwater crisis in coastal Bangladesh. In order to solve them, authorities should supply a sufficient volume of freshwater. The socio-economic development is not possible in its absence. I also would like to express my wish that more depth multidisciplinary research on the freshwater crisis and its effect in the communities from coastal Bangladesh to be undertaken, so that authorities gain a clearer picture on this grave situation and take measures to improve it

Notes

1. Ganges, Brahmaputra, and Meghna.
2. Water for bathing, cooking, drinking, and sanitation purposes.
3. Upazila is a sub-district of Bangladesh. It is the second lowest tier of regional administration in the country.
4. This is the main source of primary data, as it takes into account several people with similar or different backgrounds and reflects their opinions, ideas, beliefs, and experiences. Five FGD were held in the purpose of this study for gathering information about the types of social and economic problems arising from the water crisis, its causes, the role of the government, and to identify the sources of freshwater.
5. An in-depth interview with people who have knowledge about a specific issue. Face to face KII was used for this study.
6. The dry season begibrollyns normally in October and lasts until March. However, this situation is changing due to climate change.
7. Each trip involves half a day only to collect water.
8. Bangladeshi Taka.
9. About 20 litres.

References

Abedin, Md. Anwarul; Habiba, Umma; Shaw, Rajib. "Community perception and adaptation to safe drinking water scarcity: salinity, arsenic, and drought risks in coastal Bangladesh." *Int J Disaster Risk Sci.* 5 (2014): 110–124. DOI 10.1007/s13753-014-0021-6.

Ahmed, AMM Motaher, and Roy, Kingshuk. "Utilization and Conservation of Water Resources in Bangladesh." *Journal of Developments in Sustainable Agriculture*, Agricultural and Forestry Research Center, University of Tsukuba, Japan, Volume 2, Issue 1 (2007): 35-44.

Ansari, Md. Sazzad; Islam H.M Nurul, and Roy, Kushal. *Functionality and social acceptance of safe water, technology pond sand filter (PSF) and rainwater harvesting system (RWHS) in the southwest coastal region of Bangladesh*. Saarbrucken: VDM Verlag, 2011: 1–76.

Azad, Md. Abul Kalam., and Alam, Ashraful. "Environmental Impact of India's River Linking Project on Bangladesh." *Regional Cooperation on Transboundary Rivers*, University of Rajshahi: 210-220. Available at: http://ibrarian.net/navon/paper/Environmental_Impact_of_India_s_River_Linking_Pro.pdf?paperid=3465989. Accessed on December 30, 2017.

BBS (Bangladesh Bureau of Statistics). "Bangladesh Population and Housing Census 2011." *Statistics and Information Division*, Ministry of Planning,

Government of the People's Republic of Bangladesh, 2015, ISBN-978-984-33-8601-4.

Benneyworth, L.; Gilligan, J., Ayers; J.C., Goodbred; S., George; G., Carrico; A., Karim, M.R.; Akter, F.; Fry, D.; Donato, K., and Piya, B. "Drinking water insecurity: water quality and access in coastal south-western Bangladesh." *International Journal of Environmental Health Research* (2016). DOI: 10.1080/09603123.2016.1194383

Chong, Yu. Jeat.; Khan, Aneire.; Scheelbeek, Pauline.; Butler, Adrian.; Bowers, David., and Vineis, Paolo. "Climate change and salinity in drinking water as a global problem: using remote-sensing methods to monitor surface water salinity." *International Journal of Remote Sensing*, 35 (4) (2014): 1585-1599. https://doi.org/10.1080/01431161.2013.878065

Chowdhury, Nasima.Tanveer. "Water Management in Bangladesh: An Analytical Review." *Water Policy* (2010): 32-51. https://doi.org/10.2166/wp.2009.112

Concern Worldwide. *Water: How can we increase the world's access to clean water*? New York: Concern Worldwide US, 2012.

Curry, Eliot. "Water scarcity and the recognition of the human right to safe freshwater." *Northwestern Journal of International Human Rights*, Volume 9, Issue 1 (2010): 102-121

Dasgupta, Susmita Kamal; Farhana Akter; Khan, Zahirul Huque; Chowdhury, Sharifuzzaman, and Nishat, Ainun. "River Salinity and Climate Change: Evidence from Coastal Bangladesh." *Policy Research Paper 6817*, Volume 1, *The World Bank* (2014): 1-44. Available at: http://documents.worldbank.org/curated/en/522091468209055387/pdf/WPS6817.pdf. Accessed on March 22, 2018.

Datta, Dilip Kumar; Roy, Kushal, and Hassan Nazia. "Shrimp culture: trend, consequences and sustainability in the southwestern coastal region of Bangladesh." in Ramanathan, AL.; Bhattacharya, P.; Dittmar, T.; Prasad, MBK, Nupane, BR, editors. Chapter 15, *Management and sustainable development of coastal zone environments*. Springer: 227–244. DOI: https://doi.org/10.1007/978-90-481-3068-9_15

FAO (Food and Agriculture Organization of the United Nations). "Situation assessment report in the southwest coastal region of Bangladesh for the livelihood adaptation to climate change (LACC) project." (Report BDG/01/004/01/99).

Hoque, Md Reazul. (2009). *Access to safe drinking water in rural Bangladesh: Water governance by DPHE*. Master's Thesis, Institute of Governance Studies, BRAC University, Dhaka, Bangladesh. URI: http://hdl.handle.net/10361/279.

Huq, Saleemul, and Ayers, Jessica. "Climate Change Impacts and Response in Bangladesh." *European Parliament. DG Internal Policies of the Union,* Policy Department Economic and Scientific, IP/A/CLIM/NT/2007-09, 2008.

IPCC (Intergovernmental Panel on Climate Change). "Climate change 2007: impacts, adaptation and vulnerability." Chapter 10: "Asia" in Parry M.; Canziani O.; Palutikof J, van der Linden P, Hanson C, (editors). *The Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change*. Cambridge: Cambridge University Press: 469–506.

Islam, Rafiqul. 'Pre-and post-tsunami coastal planning and land-use policies and issues in Bangladesh." *Proceedings of the workshop on coastal area planning and management in Asian tsunami-affected countries*, Bangkok, 2004.
Accessible at http://www.fao.org/docrep/010/ag124e/AG124E05.htm

Islam, Atikul; Sakakibara, Hiroyuki; Karim, Md. Rezaul, and Sekine, Masahiko. "Potable water scarcity: options and issue in the coastal areas of Bangladesh." *J Water Health*, 11 (3) (2013): 532-542.
DOI: 10.2166/wh.2013.215.

Islam, M. M.; Chou; M.R. Kabir, and C.H. Liaw. "Rainwater: A potential alternative source for scarce safe drinking and arsenic contaminated water in Bangladesh." *Water Resources Management*, 24 (14) (2010), Springer, Netherlands: 3987–4008.
https://doi.org/10.1007/s11269-010-9643-7

Islam, M.R. "Reducing Water Poverty in Coastal Bangladesh: Is Rainwater Harvesting a Sustainable Solution?" MSc thesis at the Department of Governance and Technology for Sustainability, University of Twente, the Netherlands, 2017.

Joseph T.; Dubey B, and McBean EA. "A critical review of arsenic exposures for Bangladeshi adults." *Sci Tot Environ* (2015): 527–528, 540–551.

Kamruzzaman, A.K.M., and Ahmed, Farooque. "Study of the performance of existing pond sand filters in different parts of Bangladesh." in *The Sustainable development of water resources, water supply and environmental sanitation*, 32nd WEDC (Water, Engineering and Development Centre) conference, Colombo, Sri Lanka, 13–17 November 2006, Colombo: WEDC Publications: 377–380.

Khan, Aneire Ehmar; Scheelback, Pauline Franka Denise; Shilpi, Asma Begum; Chan, Queenie; Mojumder, Sontosh Kumar.; Rahman, Atiq.; Haines, Andy., and Vineis, Paolo. "Salinity in Drinking Water and the Risk of (Pre) Eclampsia and Gestational Hypertension in Coastal Bangladesh: A Case-Control Study." *PLOS One*, 9(9):e108715 (2014). Available from:
http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0108715; https://doi.org/10.1371/journal.pone.0108715

Lal, Murari. "Climate change-implications for Climatic change-implications for India's water resources." *Journal of Social and Economic Development,* 3 (2000): 57-87.

Mahmuduzzaman, Md.; Ahmed, Zahir Uddin.; Nuruzzaman, AKM, and Ahmed, Fazle Rabbi Sadeque. "Causes of salinity intrusion in the coastal belt of Bangladesh." *Int J Plant Res*., 4 (2014): 8–13.

Mallick, Bishawjit; Roldan-Rojas, and Fernanda Luisa. "Social Stratification in the Drinking Water Scarcity Context: Empirical Evidence of Coastal Bangladesh." *American Journal of Water Resource*, Vol. 3, No. 3 (2015): 92-99. DOI: 10.12691/ajwr-3-3-4.

MoWR (Ministry of Water Resources). *Coastal Zone Policy*. The Government People's Republic of Bangladesh, 2005. Available at: http://lib.pmo.gov.bd/legalms/pdf/Costal-Zone-Policy-2005.pdf. Accessed on March 15, 2018.

Mustari, Shoela Karim, and A.H.M. Zahedul. "Impact of Salinity on the Socio-Environmental Life of Coastal People of Bangladesh." *Asian journal of social sciences & humanities*, 3(1), (2014): 12-18.

Mustari, Sohela Karim, and A.H.M. Zehadul. "Water Scarcity: A Fact or Fiction for a Coastal Village of Bangladesh." *Mediterranean Journal of Social Sciences*, Vol. 6, No. 4 (2016): 695-702 DOI: 10.5901/mjss.2016.v7n4p695.

Quazi, Avizit Reaz. *In search of safe drinking water: In the context of climate change and salinity*. Satkhira, Bangladesh: Uttaran and Water Committee, (2006):1-38.

Rabbani, Md. Golam; Huq, Saleemul, and Rahman, Syed Hafizur. "Impacts of Climate Change on Water Resources and Human Health: Empirical Evidence from a Coastal District (Satkhira) in Bangladesh." in *Impact of Climate Change on Water and Health*. Available at: https://www.researchgate.net/publication/258237353_Impacts_of_Climate_Change_on_Water_Resources_and_Human_Health_Empirical_Evidences_from_a_Coastal_District_Satkhira_in_Bangladesh. Accessed on February 14, 2018.

Rahman, Md. Mizanur, and Bhattacharya, Amartay Kumar. *Salinity intrusion and its management aspects in Bangladesh*. J Environ Hydrol, 2006.

Rijsberman, Frank R. "Water scarcity: Fact or fiction?" *Agricultural water management* 80 (1), (2006): 5-22.

Shamsuddoha, Md., and Chowdhury, Rezaul Karim. *Climate Change Impact and Disaster Vulnerabilities in the Coastal Areas of Bangladesh*. Dhaka: COAST Trust, 2007.

Shaw, Rajib, and Danai Thaitakoo. "Water communities: Introduction and overview." *Water Communities. Community, Environment and Disaster Risk*

Management, Volume 2, ed. R. Shaw, and D. Thaitakoo Bingley: Emerald Publishers.

Sultana, Sarmin; Alam, Md. Badrul, and Ahmed, Kazi Matin. "Prioritization of Villages for Providing Safe Water Sources in Disaster Prone Sarankhola of Bagerhat District: A GIS-Based Approach." *The Bangladesh Journal of Scientific Research*. DOI: 10.3329/bjsr.v26i1-2.20226

UNDP (United Nations Development Programme) *Human development report 2006: beyond scarcity: power, poverty and the global water crisis.* 2006 (ISBN 0-230-50058-7). Available from:
http://hdr.undp.org/sites/default/files/reports/267/hdr06-complete.pdf.

UN-Water (United Nations Water), *Water security and the global water agenda: a UN-water analytical brief.* (2013). *Available* from:
http://www.unwater.org/downloads/watersecurity_analyticalbrief.pdf.

Vörösmarty, Charles J.; Green, Pamela, Salisbury, Joseph, and Lammers, Richards B. "Global water resources: vulnerability from climate change and population growth." *Science* 289 (5477) (2000): 284-288.

Watkins, K. *Human Development Report 2006-Beyond scarcity: Power, poverty and the global water crisis*. UNDP Human Development Reports (2006).

Weligamage, P.; Barker, R.; Hussain, I.; Amarasinghe, U.; Samad, M. *World Irrigation and Water Statistics*. Colombo: International Water Management Institute, 2002.

Westing, Arthur. H. *Global Resources and International Conflict: Environmental Factors in Strategic Policy and Action*. New York: Oxford University Press, 1986.

WHO and UNICEF (*World Health Organization* and *The United Nation's Children Fund*). *Global Water Supply and Sanitation Assessment 2000 Report.* (2000). Available at:
http://lib.riskreductionafrica.org/bitstream/handle/123456789/1077/179.Global%20Water%20Supply%20and%20Sanitation%20Assessment%202000%20Report.pdf?sequence=1. Accessed on March 09, 2018.

WHO and UNICEF (World Health Organization & *United Nations Children's Fund*). (2011). "Drinking water equity, safety and sustainability: a thematic report on drinking water." (2011). Joint *monitoring programme for water supply and sanitation*. Available from:
http://www.wssinfo.org/fileadmin/user_upload/resources/report_wash_low.pdf.

Wolf, Aaron, T. "Water and Human Security." *Journal of Contemporary Water Research and Education*. Oregon State University (2001): 29-37. Available at: http://ucowr.org/files/Achieved_Journal_Issues/V118_A5Water%20and%20Human%20Security.pdf. Accessed on December 30, 2017.

Zahid, Anwar, and Ahmed, Syed Reaz Uddin. "Groundwater Resources Development in Bangladesh: Contribution to Irrigation for Food Security and Constraints to Sustainability." *Bangladesh Water Development Board* (2006):27-46. Available at: http://publications.iwmi.org/pdf/H039306.pdf. Accessed on January 14, 2018.